3. CONCEPTIONS

3.1 Introduction

Assessments of the association between miscarriage and dioxin level were carried out using Models 1, 2 and 3 in pre-post SEA and post-SEA analyses (as described in Section 1.3). A composite variable called total adverse outcome was defined as the occurrence of a miscarriage, tubal pregnancy, other (non-induced) abortive pregnancy or stillbirth. The association between total adverse outcome and the father's dioxin level was carried out in parallel with the assessments of miscarriage. The association between total conceptions per father and dioxin was assessed using Models 1, 2 and 3.

In this chapter conceptions were categorized as full siblings if all conceptions resulted from a participant impregnation of one woman, regardless of the number of relationships the participant had. Analyses of each of these three variables are carried out without and then with restriction to full siblings.

Summary counts and rates of conception outcome by time of conception and the father's exposure restriction (D>10 ppt, D>5 ppt) for Models 1 and 2 are shown in Table 3-1. Rates were computed as the number of occurrences per 1000 conceptions.

In Table 3-1, there is one more live birth for each time of conception for Ranch Hands with D>10 ppt in Model 2, otherwise the sample sizes for Model 2 are the same as for Model 1.

Table 3-1

Counts and Rates of Births and Abortive Pregnancies in Conceptions Included in Models 1 and 2 Classified by Time of Conception Relative to the Father's Duty in SEA

a) **Ranch Hands with D>10 ppt**

	Time of Conception			
	Pre-SEA		Post-SEA	
	Count	(Rate)	Count	(Rate)
Abortive Pregnancies				
Miscarriage	120	(143.5)	100	(157.0)
Induced abortion	1	(1.2)	18	(28.3)
Tubal pregnancy	2	(2.4)	2	(3.1)
Other	0	(0.0)	2	(3.1)
Total Births				
Live Birth	700	(837.3)	508	(797.5)
Stillbirth	13	(15.6)	7	(11.0)
Total Pregnancies	836		637	

b) **Ranch Hands with D>5 ppt**

	Time of Conception			
	Pre-SEA		Post-SEA	
	Count	(Rate)	Count	(Rate)
Abortive Pregnancies				
Miscarriage	191	(150.2)	133	(152.7)
Induced abortion	3	(2.4)	30	(34.4)
Tubal pregnancy	3	(2.4)	3	(3.4)
Other	1	(0.8)	2	(2.3)
Total Births				
Live Birth	1058	(831.8)	690	(792.2)
Stillbirth	16	(12.6)	13	(14.9)
Total Pregnancies	1272		871	

Summary counts and rates of reproductive outcome by time of conception relative to SEA duty among conceptions included in Model 3 analyses are shown in Table 3-2.

Table 3-2

Counts and Rates of Births and Abortive Pregnancies of Conceptions Included in Model 3 Analyses Classified by Time of Conception Relative to Duty in SEA

	Time of Conception	
	Pre-SEA Count (Rate)	Post-SEA Count (Rate)
a) Abortive Pregnancies		
Miscarriage	395 (133.9)	305 (145.5)
Induced Abortion	9 (3.0)	91 (43.4)
Tubal Pregnancy	9 (3.0)	8 (3.8)
Other	3 (1.0)	4 (1.9)
b) Total Births		
Live Birth	2499 (846.8)	1664 (793.9)
Stillbirth	36 (12.2)	24 (11.5)
Total Conceptions	2951	2096

3.2 Pre-Post SEA Exposure Analyses

Miscarriage (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-3), there is no significant variation in the association between miscarriage and initial dioxin with time of conception among conceptions fathered by Ranch Hands having more than 10 ppt (p=0.795) or more than 5 ppt current dioxin (p=0.320).

Table 3-3

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restrictions: All Conceptions of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA MC	Pre-SEA Rate	Post-SEA n	Post-SEA MC	Post-SEA Rate	p-Value
a) D>10 ppt (n=1473)	Low	293	40	136.5	136	21	154.4	0.795
	Medium	406	61	150.2	310	49	158.1	
	High	137	19	138.7	191	30	157.1	
b) D>5 ppt (n=2143)	Low	352	60	170.5	199	27	135.7	0.320
	Medium	726	100	137.7	392	61	155.6	
	High	194	31	159.8	280	45	160.7	

Miscarriage (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-4 [a]), there is significant variation in the association between miscarriage and current dioxin level with time since duty in SEA and time of conception among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.014). This significance is due to the lower miscarriage rate (48.8 per 1000) among pre-SEA conceptions of Ranch Hands in the High dioxin category.

Without adjustment for covariates (Table 3-4 [b]), there is significant variation in the association between miscarriage and current dioxin level with time since duty in SEA and time of conception among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.024). This significance is due to a reversal of the association between miscarriages and dioxin in conceptions of Ranch Hands with late tours; pre-SEA miscarriages decrease with dioxin and post-SEA miscarriages increase with dioxin in this stratum.

Table 3-4

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restrictions: All Conceptions of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time of Conception	Time Since SEA (years)	Miscarriage Rate (No./n) Current Dioxin Low	Medium	High	p-Value
a) D>10 ppt (n=1475)	Pre-SEA	≤18.6	142.0 (23/162)	146.8 (32/218)	48.8 (2/41)	0.014
		>18.6	123.9 (14/113)	159.4 (33/207)	166.7 (16/96)	
	Post-SEA	≤18.6	92.1 (7/76)	136.6 (22/161)	168.5 (15/89)	
		>18.6	237.3 (14/59)	198.6 (29/146)	121.5 (13/107)	
b) D>5 ppt (n=2143)	Pre-SEA	≤18.6	170.1 (33/194)	152.4 (57/374)	126.6 (10/79)	0.024
		>18.6	120.7 (21/174)	150.3 (49/326)	168.0 (21/125)	
	Post-SEA	≤18.6	127.1 (15/118)	132.7 (28/211)	154.4 (21/136)	
		>18.6	103.9 (8/77)	202.2 (37/183)	164.4 (24/146)	

Miscarriage (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-5), there is no significant variation in the association between miscarriage and categorized current dioxin with time of conception (p=0.986). Furthermore, the association between miscarriage and time of conception among conceptions fathered by Ranch Hands in High (p=0.825), Low (p=0.744) and Unknown (p=0.864) categories do not differ significantly from the corresponding association among conceptions fathered by Comparisons in the Background category.

Table 3-5

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restriction: All Conceptions of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

	Time of Conception Relative to the Father's Duty in SEA								
Exposure	Pre-SEA			Post-SEA			Odds	Category	
Category	n	MC	Rate	n	MC	Rate	Ratio	Contrast	p-Value
Background	1712	215	125.6	1235	172	139.3	1.13	All Exp Categ	0.986
Unknown	691	100	144.7	367	57	155.3	1.09	Unk vs Bkgd	0.864
Low	344	49	142.4	212	31	146.2	1.03	Low vs Bkgd	0.744
High	204	31	152.0	282	45	159.6	1.06	High vs Bkgd	0.825
Total	2951			2096					

Miscarriage (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-6), there is no significant variation in the association between miscarriage and initial dioxin with time of conception among full siblings fathered by Ranch Hands having more than 10 ppt (p=0.330) or more than 5 ppt (p=0.228) current dioxin.

Table 3-6

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restrictions: Full Siblings of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA MC	Pre-SEA Rate	Post-SEA n	Post-SEA MC	Post-SEA Rate	p-Value
a) D>10 ppt (n=1222)	Low	273	39	142.9	98	15	153.1	0.330
	Medium	325	48	147.7	246	32	130.1	
	High	121	14	115.7	159	25	157.2	
b) D>5 ppt (n=1784)	Low	308	53	172.1	149	23	154.4	0.228
	Medium	630	86	136.5	300	42	140.0	
	High	164	25	152.4	233	35	150.2	

Miscarriage (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-7 [a]), there is borderline significant variation in the association between miscarriage and current dioxin level with time since duty in SEA and time of conception among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.076). This borderline significance is due to the reduced rate of miscarriages among pre-SEA conceptions fathered by Ranch Hands in the High current dioxin category, late tour, and the increased rate among the post-SEA conceptions in the Low current dioxin category, early tour.

Without adjustment for covariates (Table 3-7 [b]), there is borderline significant variation in the association between miscarriage and current dioxin level with time since duty in SEA and time of conception among full siblings fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.071). This borderline significance is due to the decreasing pre-SEA miscarriage rates with dioxin among conceptions fathered by Ranch Hands with late tours and increasing rates among conceptions fathered by Ranch Hands with early tours.

Table 3-7

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restrictions: Full Siblings of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time of Conception	Time Since SEA (years)	Miscarriage Rate (No./n) Current Dioxin Low	Medium	High	p-Value
a) D>10 ppt (n=1224)	Pre-SEA	≤18.6	154.4 (23/149)	152.2 (28/184)	51.3 (2/39)	0.076
		>18.6	128.7 (13/101)	144.6 (24/166)	135.8 (11/81)	
	Post-SEA	≤18.6	89.3 (5/56)	126.9 (17/134)	146.7 (11/75)	
		>18.6	238.1 (10/42)	169.6 (19/112)	117.6 (10/85)	
b) D>5 ppt (n=1784)	Pre-SEA	≤18.6	196.2 (31/158)	159.6 (53/332)	138.9 (10/72)	0.071
		>18.6	95.5 (15/157)	139.8 (39/279)	153.8 (16/104)	
	Post-SEA	≤18.6	148.1 (12/81)	125.0 (21/168)	144.1 (17/118)	
		>18.6	109.4 (7/64)	182.5 (25/137)	157.9 (18/114)	

Miscarriage (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-8), there is no significant variation in the association between miscarriage and categorized current dioxin with time of conception among full siblings (p=0.772). Furthermore, the association between miscarriage and time of conception among conceptions fathered by Ranch Hands in the High (p=0.659), Low (p=0.309) and Unknown (p=0.777) categories do not differ significantly from the corresponding association among conceptions fathered by Comparisons in the Background category.

Table 3-8

Pre-Post SEA Counts and Rates of Miscarriage

Variable: Miscarriage (MC)
Restrictions: Full Siblings of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

	Time of Conception Relative to the Father's Duty in SEA								
Exposure Category	Pre-SEA n	MC	Rate	Post-SEA n	MC	Rate	Odds Ratio	Category Contrast	p-Value
Background	1450	180	124.1	982	140	142.6	1.17	All Exp Categ	0.772
Unknown	604	92	152.3	279	46	164.9	1.10	Unk vs Bkgd	0.777
Low	282	37	131.2	168	19	113.1	0.84	Low vs Bkgd	0.309
High	176	26	147.7	232	35	150.9	1.03	High vs Bkgd	0.659
Total	2512			1661					

Total Adverse Outcome (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-9 [a]), there is no significant variation in the association between total adverse outcome and initial dioxin with time of conception among conceptions fathered by Ranch Hands with more than 10 ppt current dioxin (p=0.544).

Without adjustment for covariates (Table 3-9 [b]), there is no significant variation in the association between adverse conception outcome and initial dioxin with time of conception among conceptions fathered by Ranch Hands with more than 5 ppt current dioxin (p=0.950).

Table 3-9

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome (Advs)
Restrictions: All Conceptions of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA Advs	Pre-SEA Rate	Post-SEA n	Post-SEA Advs	Post-SEA Rate	p-Value
a) D>10 ppt (n=1454)	Low	293	44	150.2	129	23	178.3	0.544
	Medium	405	67	165.4	303	58	191.4	
	High	137	24	175.2	187	30	160.4	
b) D>5 ppt (n=2110)	Low	351	65	185.2	188	33	175.5	0.950
	Medium	724	108	149.2	379	71	187.3	
	High	194	38	195.9	274	47	171.5	

Total Adverse Outcome (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-10 [a]), there is significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA and time of conception among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.025). This significance is due to reversals in the pattern of adverse outcome rates with time of conception. The rate decreases with dioxin in pre-SEA conceptions of Ranch Hands with late tours and in post-SEA conceptions of Ranch Hands with early tours. The rate increases with dioxin in pre-SEA conceptions of Ranch Hands with early tours and post-SEA conceptions of Ranch Hands with late tours.

Without adjustment for covariates (Table 3-10 [b]), there is significant variation in the association between total adverse outcome and current dioxin with time of conception and time since duty in SEA (p=0.045). This significance is due to a high post-SEA rate (240.2 per 1000) in conceptions fathered by Ranch Hands with early tours having intermediate dioxin levels.

Table 3-10

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: All Conceptions of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Exposure Restriction	Time of Conception	Time Since SEA (years)	Abnormal Rate (No./n) Current Dioxin Low	Medium	High	p-value
a) D>10 ppt (n=1456)	Pre-SEA	≤18.6	154.3 (25/162)	160.6 (35/218)	97.6 (4/41)	0.025
		>18.6	159.3 (18/113)	169.9 (35/206)	187.5 (18/96)	
	Post-SEA	≤18.6	126.8 (9/71)	151.9 (24/158)	172.4 (15/87)	
		>18.6	298.2 (17/57)	234.0 (33/141)	122.6 (13/106)	
b) D>5 ppt (n=2110)	Pre-SEA	≤18.6	190.7 (37/194)	163.1 (61/374)	164.6 (13/79)	0.045
		>18.6	127.9 (22/172)	169.2 (55/325)	184.0 (23/125)	
	Post-SEA	≤18.6	181.8 (20/110)	147.1 (30/204)	172.9 (23/133)	
		>18.6	137.0 (10/73)	240.2 (43/179)	176.1 (25/142)	

Total Adverse Outcome (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-11), there is no significant overall variation in the association between total adverse outcome and categorized current dioxin with time of conception (p=0.859). Furthermore, the association between total adverse outcome and time of conception among conceptions fathered by Ranch Hands in the High (p=0.523), Low (p=0.735) and Unknown (p=0.727) categories are not significantly different from the corresponding association among conceptions fathered by Comparisons in the Background category.

Table 3-11

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: All Conceptions of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

	Time of Conception Relative to the Father's Duty in SEA								
Exposure Category	Pre-SEA n	Pre-SEA Abn	Pre-SEA Rate	Post-SEA n	Post-SEA Abn	Post-SEA Rate	Odds Ratio	Category Contrast	p-Value
Background	1706	247	144.8	1175	194	165.1	1.17	All Exp Categ	0.859
Unknown	689	107	155.3	347	65	187.3	1.25	Unk vs Bkgd	0.727
Low	343	53	154.5	208	34	163.5	1.07	Low vs Bkgd	0.735
High	204	36	176.5	275	48	174.5	0.99	High vs Bkgd	0.523
Total	2942			2005					

Total Adverse Outcome (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-12 [a]), there is no significant variation in the association between total adverse outcomes and initial dioxin with time of conception among full siblings fathered by Ranch Hands with more than 10 ppt current dioxin (p=0.874).

Without adjustment for covariates (Table 3-12 [b]), there is no significant variation in the association between total adverse outcomes and initial dioxin with time of conception among full siblings fathered by Ranch Hands with more than 5 ppt current dioxin (p=0.727).

Table 3-12

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA Advs	Pre-SEA Rate	Post-SEA n	Post-SEA Advs	Post-SEA Rate	p-Value
a) D>10 ppt (n=1211)	Low	273	42	153.8	94	16	170.2	0.874
	Medium	325	52	160.0	242	40	165.3	
	High	121	18	148.8	156	25	160.3	
b) D>5 ppt (n=1763)	Low	307	58	188.9	141	27	191.5	0.727
	Medium	630	92	146.0	292	51	174.7	
	High	164	30	182.9	229	36	157.2	

Total Adverse Outcome (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-13 [a]), there is borderline significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA and time of conception among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.056). This significance is due a reversal in the pattern of adverse outcome rates with time of conception in conceptions of Ranch Hands with late tours. Among pre-SEA conceptions, the rate decreases with increasing current dioxin. Among post-SEA conceptions, the rate increases with increasing current dioxin.

Without adjustment for covariates (Table 3-13 [b]), there is borderline significant variation in the association between total adverse outcomes and current dioxin with time since duty in SEA and time of conception among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.076). This significance is due to a reversal in the pattern of adverse outcome rates with time of conception. Among pre-SEA conceptions of Ranch Hands with early tours, the rate increases with increasing current dioxin and among pre-SEA conceptions of Ranch Hands with late tours the rate decreases with current dioxin. Among post-SEA conceptions no such trends are apparent.

Table 3-13

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Exposure Restriction	Time of Conception	Time Since SEA (years)	Abnormal Rate (No./n) Current Dioxin Low	Medium	High	p-value
a) D>10 ppt (n=1213)	Pre-SEA	≤18.6	167.8 (25/149)	157.6 (29/184)	102.6 (4/39)	0.056
		>18.6	158.4 (16/101)	156.6 (26/166)	148.1 (12/81)	
	Post-SEA	≤18.6	113.2 (6/53)	143.9 (19/132)	150.7 (11/73)	
		>18.6	317.1 (13/41)	200.0 (22/110)	119.0 (10/84)	
b) D>5 ppt (n=1763)	Pre-SEA	≤18.6	221.5 (35/158)	168.7 (56/332)	166.7 (12/72)	0.076
		>18.6	102.6 (16/156)	157.7 (44/279)	163.5 (17/104)	
	Post-SEA	≤18.6	213.3 (16/75)	134.1 (22/164)	165.2 (19/115)	
		>18.6	131.1 (8/61)	229.6 (31/135)	160.7 (18/112)	

Total Adverse Outcome (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-14), there is no overall variation in the association between total adverse outcome and categorized current dioxin with time of conception (p=0.723) in full siblings. Furthermore, the association between total adverse outcome and time of conception in

conceptions fathered by Ranch Hands in the High (p=0.460), Low (p=0.357) and Unknown (p=0.979) categories are not significantly different from the corresponding association among conceptions fathered by Comparisons in the Background category.

Table 3-14

Pre-Post SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

	Time of Conception Relative to the Father's Duty in SEA								
Exposure	Pre-SEA			Post-SEA			Odds	Category	
Category	n	Abn	Rate	n	Abn	Rate	Ratio	Contrast	p-Value
Background	1445	207	143.3	946	161	170.2	1.23	All Exp Categ	0.723
Unknown	603	98	162.5	264	51	193.2	1.23	Unk vs Bkgd	0.979
Low	282	40	141.8	166	22	132.5	0.92	Low vs Bkgd	0.357
High	176	29	164.8	227	37	163.0	0.99	High vs Bkgd	0.460
Total	2506			1603					

The total conceptions data consisted of at least one conception per father because fathers with no conceptions were not considered. Fathers with conceptions in both pre-SEA and post-SEA were considered twice. The data for total conceptions is very non-normally distributed. Hence, total conception means are reported for descriptive purposes but probability levels are reported from the analyses of ranked values of total conceptions.

Total Conceptions (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-15 [a]), there is no significant variation in the association between total conceptions and initial dioxin with time of conception among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.143).

Without adjustment for covariates (Table 3-15 [b]), there is no significant variation in the association between total conceptions and initial dioxin with time of conception among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.177).

Table 3-15

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA Mean	Post-SEA n	Post-SEA Mean	p-Value
a) D>10 ppt (n=560) (R^2=0.04)	Low	96	3.05	56	2.43	0.143
	Medium	139	2.92	139	2.23	
	High	51	2.69	79	2.42	
b) D>5 ppt (n=827) (R^2=0.04)	Low	128	2.75	94	2.12	0.177
	Medium	238	3.05	177	2.21	
	High	73	2.66	117	2.39	

Total Conceptions (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-16 [a] and [b]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA and time of conception among conceptions fathered by Ranch Hands having more than 10 ppt (p=0.147) while there is borderline significance in conceptions of fathers having more than 5 ppt dioxin (p=0.083). The borderline significance is due to the increasing trends in total post-SEA conceptions with increasing levels of dioxin.

Table 3-16

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Exposure Restriction	Time of Conception	Time Since SEA (years)	Mean total Conceptions (n) Current Dioxin Low	Medium	High	p-value
a) D>10 ppt (n=562) (R^2=0.04)	Pre-SEA	≤18.6	2.95 (55)	3.16 (69)	2.16 (19)	0.147
		>18.6	2.97 (38)	2.80 (74)	3.00 (32)	
	Post-SEA	≤18.6	2.24 (34)	2.30 (70)	2.47 (36)	
		>18.6	2.36 (25)	2.28 (64)	2.33 (46)	
b) D>5 ppt (n=827) (R^2=0.04)	Pre-SEA	≤18.6	2.73 (71)	3.07 (122)	2.47 (32)	0.083
		>18.6	2.90 (60)	2.94 (111)	2.91 (43)	
	Post-SEA	≤18.6	2.11 (56)	2.18 (97)	2.57 (53)	
		>18.6	2.03 (38)	2.20 (83)	2.39 (61)	

Total Conceptions (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-17), there is no significant variation in the overall association between total conceptions and categorized current dioxin with time of conception (p=0.168). However, the change in the average number of conceptions from pre-SEA to post-SEA among those fathered by Ranch Hands in the High category (2.72-2.47=0.25) is significantly less than

that (2.91-2.17=0.74) of Comparisons in the Background category (p=0.026). Corresponding contrasts of pre-SEA to post-SEA changes in conceptions of Ranch Hands in the Low (p=0.902) and Unknown (p=0.986) categories with changes among Comparisons in the Background category are not significant.

Table 3-17

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

Exposure Category	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA Mean	Post-SEA n	Post-SEA Mean	Exposure Contrast	p-Value
Background	588	2.91	570	2.17	All Exp Categ	0.168
Unknown	244	2.83	178	2.06	Unk vs Bkgd	0.986
Low	113	3.04	98	2.16	Low vs Bkgd	0.902
High	75	2.72	114	2.47	High vs Bkgd	0.026
Total	1020		960		(R^2=0.05)	

Total Conceptions (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-18 [a]), there is significant variation in the association between total conceptions and initial dioxin with time of conception among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.026). This significance is due to a decrease in pre-SEA total conceptions with initial dioxin and no trend in post-SEA total conceptions.

Without adjustment for covariates (Table 3-18 [b]), there is significant variation in the association between total conceptions and initial dioxin with time of conception among full siblings fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.033). This significance is due to an increase in post-SEA total conceptions with initial dioxin and no trend in pre-SEA total conceptions.

Table 3-18

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands
Model 1: Log_2(Initial Dioxin)

Exposure Restriction	Initial Dioxin	Time of Conception Relative to the Father's Duty in SEA: Pre-SEA n	Pre-SEA Mean	Post-SEA n	Post-SEA Mean	p-Value
a) D>10 ppt	Low	84	3.25	43	2.28	0.026
(n=471)	Medium	115	2.83	116	2.12	
(R^2=0.06)	High	45	2.69	68	2.34	
b) D>5 ppt	Low	108	2.85	75	1.99	0.033
(n=695)	Medium	206	3.06	144	2.08	
(R^2=0.07)	High	61	2.69	101	2.31	

Total Conceptions (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-19 [a] and [b]), there is significant variation in the association between total conceptions and current dioxin with time since duty in SEA and time of conception among full siblings fathered by Ranch Hands having more than 10 ppt (p=0.048) and more than 5 ppt (p=0.025) current dioxin. The significance for both exposure restrictions is due to inconsistent trends with dioxin in pre-SEA and post-SEA conceptions.

Table 3-19

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands
Model 2: Log_2(Current Dioxin), Time

Exposure Restriction	Time of Conception	Time Since SEA (years)	Mean total Conceptions (n) Current Dioxin Low	Medium	High	p-value
a) D>10 ppt (n=473) (R^2=0.07)	Pre-SEA	≤18.6	3.04 (49)	3.07 (60)	2.17 (18)	0.048
		>18.6	3.26 (31)	2.72 (61)	3.12 (26)	
	Post-SEA	≤18.6	2.07 (27)	2.27 (59)	2.34 (32)	
		>18.6	2.21 (19)	2.11 (53)	2.24 (38)	
b) D>5 ppt (n=695) (R^2=0.08)	Pre-SEA	≤18.6	2.87 (55)	3.05 (109)	2.48 (29)	0.025
		>18.6	2.91 (54)	2.97 (94)	3.06 (34)	
	Post-SEA	≤18.6	2.02 (40)	2.07 (81)	2.51 (47)	
		>18.6	1.88 (34)	2.01 (68)	2.28 (50)	

Total Conceptions (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-20), there is no significant variation in the overall association between total conceptions and categorized current dioxin with time of conception (p=0.174). The change in the average number of conceptions from pre-SEA to post-SEA fathered by Ranch Hands in the High category (2.79-2.39=0.40) is significantly less than that

(2.91-2.07=0.84) of Comparisons in the Background category (p=0.036). Corresponding contrasts of pre-SEA to post-SEA changes in conceptions of Ranch Hands in the Low (p=0.483) and Unknown (p=0.841) categories with changes among conceptions of Comparisons in the Background category are not significant.

Table 3-20

Pre-Post SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands and Comparisons
Model 3: Categorized Current Dioxin

	Time of Conception Relative to the Father's Duty in SEA					
Exposure Category	Pre-SEA n	Pre-SEA Mean	Post-SEA n	Post-SEA Mean	Exposure Contrast	p-Value
Background	499	2.91	475	2.07	All Exp Categ	0.174
Unknown	209	2.89	145	1.92	Unk vs Bkgd	0.841
Low	97	2.91	82	2.05	Low vs Bkgd	0.483
High	63	2.79	97	2.39	High vs Bkgd	0.036
Total	868		799		(R^2=0.08)	

3.3 Post-SEA Exposure Analyses

The same series of analyses were carried out on conceptions occurring during or after the father's return from duty in SEA. The results are shown in Tables 3-21 through 3-38. Each analysis is carried out without and again with restriction to full siblings.

Miscarriage (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-21 [a] and [b]), there is no significant association between miscarriage and initial dioxin among conceptions of Ranch Hands having more than 10 ppt (p=0.588) or more than 5 ppt (p=0.378) current dioxin.

After adjustment for covariates (Table 3-21 [c]), there is significant variation in the association between miscarriage and initial dioxin with the mother's age among conceptions fathered by Ranch Hands having more than 10 ppt (p=0.005). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found no significant association between miscarriage and initial dioxin among conceptions of mothers who were less than 27 years at the time of the conception (p=0.198), or among conceptions of mothers who were more than 27 years at the time of the conception (p=0.867).

After adjustment for covariates (Table 3-21 [d]), there is no significant association between miscarriage and initial dioxin among conceptions fathered by Ranch Hands having more than 5 ppt (p=0.398) current dioxin.

Table 3-21

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: All Conceptions of Ranch Hands
Conceptions during or after the
Father's Duty in SEA
Model 1: Log(Initial Dioxin)

Ranch Hands - Log(Initial) - Unadjusted

Exposure Restriction	Initial Dioxin	Miscarriage n	Miscarriage Rate (n)	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=637)	Low	136	154.4(21)	1.05(0.88,1.26)	0.588
	Medium	310	158.1(49)		
	High	191	157.1(30)		
b) D>5 ppt (n=871)	Low	199	135.7(27)	1.06(0.93,1.21)	0.378
	Medium	392	155.6(61)		
	High	280	160.7(45)		

Table 3-21 (Continued)

Ranch Hands - Log2(Initial) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=569)	****	****	M-AGE*DIOXIN (p=0.005) RACE(p=0.017) OCC(p=0.039) C-TIME(p=0.054)
d) D>5 ppt (n=767)	1.07(0.92,1.25)	0.398	OCC(p=0.059)

Miscarriage (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-22 [a]), there is significant variation in the association between miscarriage and current dioxin with time since duty in SEA among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.022). Among conceptions of Ranch Hands having late tours, the association between miscarriage and current dioxin is borderline significant (OR=1.31, 95% CI 0.98-1.74, p=0.066) and among conceptions of Ranch Hands having early tours, the association is not significant (OR=0.84, 95% CI 0.66-1.08, p=0.170). The significance is caused by the first of these odds ratios being greater than one and the second being less than one.

Without adjustment for covariates (Table 3-22 [b]), there is no significant variation in the association between miscarriage and current dioxin with time duty in SEA among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.250). Furthermore, there is no significant association between miscarriage and current dioxin among conceptions of Ranch Hands with late (p=0.220) or early (p=0.712) tours.

After adjustment for covariates (Table 3-22 [c]), there is significant variation in the association between miscarriage and current dioxin with time and the father's military occupation in SEA (p=0.018). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found that for Ranch Hands officers, there is a significant change in the association between miscarriage and current dioxin with time since duty in SEA (p=0.022). Among the officers having late tours, the association between miscarriage and current dioxin is not significant (OR=4.55, 95% CI 0.40-52.3, p=0.224) while the same association is borderline significant (OR=0.06, 95% CI 0.002-1.43, p=0.075) for those with early tours. For the enlisted ground personnel, there is a borderline significant change in the association between

miscarriage and current dioxin with time since duty in SEA (p=0.069). Among the enlisted ground personnel having late tours, the association between miscarriage and current dioxin is significant (OR=1.46, 95% CI 1.04-2.05, p=0.030) while for those with early tours this association is not significant (OR=0.94, 95% CI 0.65-1.34, p=0.712). There is no significant change in the association between miscarriage and current dioxin with time since duty in SEA (p=0.218) for the enlisted flyers and there is no significant association between miscarriage and current dioxin among those with late (p=0.376) or early tours (p=0.451).

After adjustment for covariates (Table 3-22 [d]), there is significant variation in the association between miscarriage and current dioxin with time since duty in SEA and the father's military occupation in SEA (p=0.044). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found that for the enlisted flyers is there a significant change in the association between miscarriage and current dioxin with time since duty in SEA (p=0.021). For this stratum there is no significant association between miscarriage and current dioxin among conceptions fathered by Ranch Hands with late tours (p=0.223) while there is a significant positive association for those with early tours (OR=2.58, 95% CI 1.01-6.57, p=0.043). No significant associations were found in the other occupational strata.

If the above interaction is ignored, there is no significant change in the association between miscarriage and current dioxin with time since duty in SEA (p=0.295). Furthermore, there is no significant association between miscarriage and current dioxin among conceptions fathered by Ranch Hands with late (p=0.130) or early (p=0.959) tours.

Table 3-22

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: All Conceptions of Ranch Hands
Conceptions during or after the Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Miscarriage Rate (No./n) Current Dioxin Low	Medium	High	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=638)						0.022
	≤18.6	92.1 (7/76)	136.6 (22/161)	168.5 (15/89)	1.31(0.98,1.74)	0.066
	>18.6	237.3 (14/59)	198.6 (29/146)	121.5 (13/107)	0.84(0.66,1.08)	0.170
b) D>5 ppt (n=871)						0.250
	≤18.6	127.1 (15/118)	132.7 (28/211)	154.4 (21/136)	1.13(0.93,1.38)	0.220
	>18.6	103.9 (8/77)	202.2 (37/183)	164.4 (24/146)	0.97(0.81,1.16)	0.712

Table 3-22 (Continued)

Ranch Hands - Log_2(Current), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=570)				OCC*TIME* DIOXIN(p=0.018)
	≤18.6	****	****	RACE(p=0.014)
	>18.6	****	****	
d) D>5 ppt (n=767)			0.295***	OCC*TIME* DIOXIN(p=0.044)
	≤18.6	1.17(0.95,1.43)***	0.130***	
	>18.6	1.01(0.82,1.23)***	0.959***	

Miscarriage (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-23 [a]), there is no significant overall association between miscarriage and categorized dioxin (p=0.772). Furthermore, the miscarriage rates in conceptions fathered by Ranch Hands in the High (p=0.380), Low (p=0.788) and Unknown (p=0.441) categories are not significantly different from the rate in conceptions fathered by Comparisons in the Background category.

After adjustment for covariates (Table 3-23 [b]), there is significant variation in the association between post-SEA miscarriage and categorized current dioxin with the mother's age at the time of the conception (p=0.038). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found no significant overall association between miscarriage and categorized current dioxin among conceptions of mothers who were less than 27 years at the time of the conception (p=0.273). Among such conceptions, there is a borderline significant difference between the miscarriage rate in conceptions of Ranch Hands in the High category and the rate in conceptions of Comparisons in the Background category (OR=1.57, 95% CI 0.97-2.54, p=0.064). Corresponding contrasts of miscarriage rates in conceptions of Ranch Hands in the Unknown (p=0.238) and Low (p=0.810) categories with the rate in conceptions of Comparisons in the Background category are not significant. There is no significant association between miscarriage and categorized current dioxin in conceptions of mothers who were older than 27

years at the time of the conception (p=0.586). Furthermore, among such conceptions, there is no significant difference between the miscarriage rates in conceptions fathered by Ranch Hands in the High (p=0.697) or Low (p=0.852) or Unknown (p=0.204) categories with the rate in conceptions fathered by Comparisons in the Background category.

If this interaction is ignored (Table 3-23 [b]), there is no significant overall association between miscarriage and categorized current dioxin (p=0.678). Furthermore, there is no significant difference between the miscarriage rate in conceptions of Ranch Hands in the High (p=0.230), Low (p=0.750) or Unknown (p=0.933) categories and the rate in conceptions of Comparisons in the Background category.

Table 3-23

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: All Conceptions of Ranch Hands and Comparisons Conceptions during or after the Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Miscarriage Rate (n)	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	1235	139.3(172)	All Exp Categ		0.772
Unknown	367	155.3(57)	Unk vs Bkgd	1.14(0.82,1.57)	0.441
Low	212	146.2(31)	Low vs Bkgd	1.06(0.70,1.60)	0.788
High	282	159.6(45)	High vs Bkgd	1.17(0.82,1.68)	0.380
Total	2096				

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	1044	All Exp Categ		0.678***	SMOKE(p=0.001)
Unknown	313	Unk vs Bkgd	0.98(0.68,1.42)***	0.933***	M-AGE*DIOXIN
Low	189	Low vs Bkgd	1.07(0.69,1.67)***	0.750***	(p=0.038)
High	250	High vs Bkgd	1.26(0.86,1.86)***	0.230***	
Total	1796				

Miscarriage (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-24 [a] and [b]), there is no significant association between miscarriage and initial dioxin among full siblings fathered by Ranch Hands with more than 10 ppt (p=0.463) or more than 5 ppt (p=0.713) current dioxin.

After adjustment for covariates (Table 3-24 [c]), there is significant variation in the association between miscarriage and initial dioxin with the mother's age at the time of the conception (p=0.001) in full siblings fathered by Ranch Hands with more than 10 ppt current dioxin. The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found that relative risks in conceptions of mothers less than 27 (p=0.146) and older than 27 years (p=0.569) at the time of the conception were not significant.

After adjustment for covariates (Table 3-24 [d]), there is no significant association between miscarriage and initial dioxin among full siblings fathered by Ranch Hands with more than 5 ppt current dioxin (p=0.457).

Table 3-24

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: Full Siblings Conceptions of Ranch Hands Conceptions during or after the Father's Duty in SEA
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Miscarriage Rate (n)	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=503)	Low	98	153.1(15)	1.08(0.88,1.32)	0.463
	Medium	246	130.1(32)		
	High	159	157.2(25)		
b) D>5 ppt (n=682)	Low	149	154.4(23)	1.03(0.89,1.19)	0.713
	Medium	300	140.0(42)		
	High	233	150.2(35)		

Table 3-24 (Continued)

Ranch Hands - Log_2(Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=398)	****	****	M-AGE* DIOXIN(p=0.001)
d) D>5 ppt (n=520)	1.06(0.91,1.24)	0.457	None

Miscarriage (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-25 [a]), there is borderline significant variation in the association between miscarriage and the father's current dioxin level with time since duty in SEA among full siblings fathered by Ranch Hands with more than 10 ppt current dioxin (p=0.076). Among conceptions of Ranch Hands having late tours, the association between miscarriage and current dioxin is positive and not significant (p=0.366) and among conceptions of Ranch Hands early tours, the association is negative and not significant (p=0.119).

Without adjustment for covariates (Table 3-25 [b]), there is no significant variation in the association between miscarriage and current dioxin with time since duty in SEA among full siblings fathered by Ranch Hands with more than 5 ppt current dioxin (p=0.528). Furthermore, the association between miscarriage and current dioxin is not significant among conceptions of Ranch Hands having late (p=0.722) or early (p=0.594) tours.

After adjustment for covariates (Table 3-25 [c]), there is significant variation in the association between miscarriage and current dioxin with time since duty in SEA and the father's military occupation in SEA (p=0.027). The basis for these significances are displayed in Appendix Table A-1. These stratified analyses found that the association between miscarriage and the father's current dioxin level is not significant among conceptions fathered by Ranch Hands having late or early tours for any of the father's military occupations in SEA. If this interaction is ignored, then there is a significant association between miscarriage and current dioxin in conceptions fathered by Ranch Hands having late tours (OR=1.57, 95% CI 1.12-2.21, p=0.009) but no significant association in conceptions fathered by Ranch Hands having early tours (p=0.650).

After adjustment for covariates (Table 3-25 [d]), there is significant variation in the association between miscarriage and current dioxin with time since duty in SEA and the father's military occupation in SEA (p=0.017). The basis for these significances are displayed in Appendix Table A-1. These stratified analyses found borderline significantly High relative risks in conceptions fathered by officers having late tours (OR=3.07, 95% CI 0.86-10.9, p=0.083) and in conceptions fathered by enlisted flyers having early tours (OR=2.06, 95% CI 0.98-4.33, p=0.054). None of the remaining relative risks were significant.

If this interaction is ignored (Table 3-25 [d]), there is no significant overall association between miscarriage and current dioxin with time since duty in SEA in conceptions fathered by Ranch Hands with more than 5 ppt current dioxin (p=0.482). Furthermore, there is no significant association between miscarriage and current dioxin in conceptions of Ranch Hands with late (p=0.556) or early (p=0.746) tours.

Table 3-25

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: Full Siblings of Ranch Hands
Conceptions during or after the Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Miscarriage Rate (No./n) Current Dioxin Low	Medium	High	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=504)						0.076
	≤18.6	89.3 (5/56)	126.9 (17/134)	146.7 (11/75)	1.29(0.94,1.78)	0.119
	>18.6	238.1 (10/42)	169.6 (19/112)	117.6 (10/85)	0.88(0.66,1.17)	0.366
b) D>5 ppt (n=682)						0.528
	≤18.6	148.1 (12/81)	125.0 (21/168)	144.1 (17/118)	1.06(0.85,1.33)	0.594
	>18.6	109.4 (7/64)	182.5 (25/137)	157.9 (18/114)	0.96(0.78,1.18)	0.722

Table 3-25 (Continued)

Ranch Hands - Log_2(Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=469)			0.095***	OCC*TIME* DIOXIN(p=0.027)
	≤18.6	1.57(1.12,2.21)***	0.009***	
	>18.6	0.92(0.66,1.30)***	0.650***	
d) D>5 ppt (n=624)			0.482***	OCC*TIME* DIOXIN(p=0.017)
	≤18.6	1.08(0.84,1.39)***	0.556***	
	>18.6	0.96(0.76,1.22)***	0.746***	

Miscarriage (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-26 [a]), there is no significant overall association between miscarriage and categorized current dioxin in full siblings (p=0.497). Furthermore, there is no significant difference between the miscarriage rate in conceptions fathered by Ranch Hands in the High (p=0.746), Low (p=0.307) or Unknown (p=0.354) categories with the rate in conceptions fathered by Comparisons in the Background category.

After adjustment for covariates (Table 3-26 [b]), there is no significant overall association between miscarriage and categorized current dioxin in full siblings (p=0.407). Furthermore, there is no significant difference between the miscarriage rate in conceptions fathered by Ranch Hands in the High (p=0.443), Low (p=0.184) or Unknown (p=0.986) categories with the rate in conceptions fathered by Comparisons in the Background category.

Table 3-26

Post-SEA Counts and Rates of Miscarriage

Variable: Miscarriage
Restrictions: Full Siblings of Ranch Hands and Comparisons
Conceptions during or after the
Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Miscarriage Rate (n)	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	982	142.6(140)	All Exp Categ		0.497
Unknown	279	164.9(46)	Unk vs Bkgd	1.19(0.83,1.71)	0.354
Low	168	113.1(19)	Low vs Bkgd	0.77(0.46,1.28)	0.307
High	232	150.9(35)	High vs Bkgd	1.07(0.72,1.60)	0.746
Total	1661				

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	860	All Exp Categ		0.407	SMOKE(p=0.047)
Unknown	246	Unk vs Bkgd	1.00(0.66,1.50)	0.986	
Low	156	Low vs Bkgd	0.69(0.40,1.20)	0.184	
High	215	High vs Bkgd	1.18(0.78,1.78)	0.443	
Total	1477				

Total adverse outcome (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-27 [a] and [b]), there is no significant association between total adverse outcome and initial dioxin among conceptions fathered by Ranch Hands having more than 10 ppt (p=0.827) or more than 5 ppt (p=0.880) current dioxin.

After adjustment for covariates (Table 3-27 [c]), there is significant variation in the association between total adverse outcome and initial dioxin level with the mother's age at the time of conception in conceptions fathered by Ranch Hands having more than 10 ppt (p=0.015). The basis for this interaction is displayed in Appendix Table A-1. These stratified analyses found a borderline significant positive association among mothers less than 27 years of age (p=0.106) while the association was not significant among mothers older than 27.

After adjustment for covariates (Table 3-27 [d]), there is significant variation in the association between total adverse outcome and initial dioxin with the father's military occupation (p=0.009) and race (p=0.043) among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin. The basis for this interaction is displayed in Appendix Table A-1. These stratified analyses found a significant positive association between total adverse outcome and initial dioxin among conceptions fathered by nonblack officers (p=0.017) while the same association is borderline significant among conceptions of Black enlisted personnel (p=0.088). None of the other strata exhibited a significant association between total adverse outcome and initial dioxin.

Table 3-27

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: All Conceptions of Ranch Hands
Conceptions during or after the
Father's Duty in SEA
Model 1: Log_2(Initial Dioxin)

Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Adverse Rate(n)	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=619)	Low	129	178.3(23)	0.98(0.82,1.17)	0.827
	Medium	303	191.4(58)		
	High	187	160.4(30)		
b) D>5 ppt (n=841)	Low	188	175.5(33)	0.99(0.87,1.12)	0.880
	Medium	379	187.3(71)		
	High	274	171.5(47)		

Table 3-27 (Continued)

Ranch Hands - Log_2(Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=555)	****	****	RACE(p=0.018) SMOKE(p=0.026) M-AGE*DIOXIN (p=0.015) OCC(p=0.020) C-TIME(p=0.074)
d) D>5 ppt (n=742)	****	****	RACE*DIOXIN (p=0.043) OCC*DIOXIN (p=0.009)

Total Adverse Outcome (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-28 [a]), there is significant variation in the association between total adverse outcomes and current dioxin with time since duty in SEA among post-SEA conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.012). This significance is due to a borderline significant decreased risk among conceptions of Ranch Hands with early tours (OR=0.77, 95% CI 0.60-0.98, p=0.032) and a nonsignificant increased risk in conceptions of Ranch Hands with late tours (OR=1.23, 95% CI 0.93-1.62, p=0.150).

Without adjustment for covariates (Table 3-28 [b]), there is no significant variation in the association between total adverse outcomes and current dioxin with time since duty in SEA among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.316). Furthermore, there is no significant association between adverse outcome and current dioxin among conceptions of Ranch Hands with late (p=0.710) or early (p=0.285) tours.

After adjustment for covariates (Table 3-28 [c]), there is significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA with the father's military occupation in conceptions of Ranch Hands having more than 10 ppt current dioxin (p=0.034). The basis for this variation in risk is displayed in Appendix Table A-1. These stratified analyses found that in conceptions fathered by officers and enlisted ground personnel, the association between total adverse outcome and current dioxin was positive among conceptions of fathers having late tours and the association was negative among conceptions of fathers having early tours.

In conceptions fathered by enlisted flyers, the association was negative among the conceptions of fathers with late tours and positive in conceptions of those with early tours. Only the positive association between total adverse outcome and current dioxin in conceptions fathered by enlisted ground personnel with late tours was significant (p=0.029).

If this interaction is ignored, there is a significant overall association between total adverse outcome and current dioxin with time since duty in SEA (p=0.009). This significance is due to a significant positive association among conceptions of Ranch Hands with late tours (OR=1.50, 95% CI 1.10-2.05, p=0.011) and a nonsignificant negative association among conceptions of Ranch Hands with early tours (OR=0.89, 95% CI 0.66-1.20, p=0.436).

After adjustment for covariates (Table 3-28 [d]), there is significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA and the father's military occupation in SEA. (p=0.007). The basis for this variation in risk is displayed in Appendix Table A-1. These stratified analyses found a significantly increased risk of adverse outcomes among conceptions of enlisted flyers with early tours (OR=2.81, 95% CI 1.15-6.91, p=0.022) and a borderline significant (p=0.089) increased risk of adverse outcomes among conceptions of officers with late tours. None of the remaining four strata exhibited a significant association between total adverse outcome and current dioxin.

Table 3-28

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: All Conceptions of Ranch Hands
Conceptions during or after the Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Adverse Rate (No./n) Current Dioxin Low	Medium	High	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=620)						0.012
	≤18.6	126.8 (9/71)	151.9 (24/158)	172.4 (15/87)	1.23(0.93,1.62)	0.150
	>18.6	298.2 (17/57)	234.0 (33/141)	122.6 (13/106)	0.77(0.60,0.98)	0.032
b) D>5 ppt (n=841)						0.316
	≤18.6	181.8 (20/110)	147.1 (30/204)	172.9 (23/133)	1.03(0.86,1.25)	0.710
	>18.6	137.0 (10/73)	240.2 (43/179)	176.1 (25/142)	0.91(0.76,1.08)	0.285

Ranch Hands - Log_2(Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=556)			0.009***	SMOKE(p=0.055) OCC*TIME*
	≤18.6	1.50(1.10,2.05)***	0.011***	DIOXIN(p=0.034) RACE(p=0.017)
	>18.6	0.89(0.66,1.20)***	0.436***	
d) D>5 ppt (n=742)				OCC*TIME* DIOXIN(p=0.007)
	≤18.6	****	****	
	>18.6	****	****	

Total Adverse Outcome (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-29 [a]), there is no significant overall association between total adverse outcome and categorized current dioxin (p=0.792). Furthermore, the total adverse outcome rate among conceptions fathered by Ranch Hands in the High (p=0.706), Low (p=0.953) and Unknown (p=0.333) categories are not significantly different from the rate among conceptions fathered by Comparisons in the Background category.

After adjustment for covariates (Table 3-29 [b]), there is significant variation in the association between total adverse outcome and categorized current dioxin with the mother's age at the time of conception (p=0.010). The basis for this variation in risk is displayed in Appendix Table A-1. These stratified analyses found a significant difference between the total adverse outcome rate among conceptions fathered by Ranch Hands in the Unknown current dioxin category and the rate among conceptions fathered by Comparisons in the Background category with the mothers being less than 27 years old at the time of conception (OR=1.67, 95% CI 1.02-2.72, p=0.039). The other strata exhibited no significant associations.

Table 3-29

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: All Conceptions of Ranch Hands and Comparisons Conceptions during or after the Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Adverse Rate (n)	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	1175	165.1(194)	All Exp Categ		0.792
Unknown	347	187.3(65)	Unk vs Bkgd	0.86(0.63,1.17)	0.333
Low	208	163.5(34)	Low vs Bkgd	1.01(0.68(1.51)	0.953
High	275	174.5(48)	High vs Bkgd	0.94(0.66,1.32)	0.706
Total	2005				

Table 3-29 (Continued)

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	1005	All Exp Categ	****	****	M-AGE*DIOXIN(p=0.010)
Unknown	295	Unk vs Bkgd			OCC(p=0.025)
Low	187	Low vs Bkgd			SMOKE(p=0.001)
High	244	High vs Bkgd			
Total	1731				

Total Adverse Outcome (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-30 [a] and [b]), there is no significant association between total adverse outcome and initial dioxin among full siblings fathered by Ranch Hands having more than 10 ppt (p=0.983) or more than 5 ppt (p=0.592) current dioxin.

After adjustment for covariates (Table 3-30 [c]), there is significant variation in the association between total adverse outcome and initial dioxin with the mother's age at the time of conception among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.004). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found no significant risk of total adverse outcome among conceptions in either stratum defined by the mother's age.

After adjustment for covariates (Table 3-30 [d]), there is significant variation in the association between total adverse outcome and initial dioxin with the father's military occupation (p=0.002), time to conception from the end of the tour (p=0.038) and the mother's age at the time of conception (p=0.009) among full siblings fathered by Ranch Hands having more than 5 ppt current dioxin. The association between total adverse outcome and initial dioxin was computed for each of the 12 combinations of time to conception from the end of the tour, the mother's age and the father's occupation. As expected, many empty cells were observed and significance testing became meaningless. Instead, total adverse outcome rates are presented for each level of each occupation. The same is done for each level of conception time and the mother's age. The associated rates are shown in Appendix Table A-1. The significance testing for occupation is adjusted for the time of conception and the mother's age. Only for the enlisted ground stratum is there a significant association between total adverse outcome and initial dioxin (OR=5.35 95% CI 1.28-22.3, p=0.021). Similarly, only for conceptions within 4 years of the end of the tour is there a significant association between total adverse

outcome and initial dioxin (OR=26.2, 95% CI 2.26-303, p=0.009). No significance was detected between total adverse outcome and initial dioxin in conceptions of mothers 27 years old or younger or in conceptions of mothers older than 27, adjusted for occupation and time of conception.

Table 3-30

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands
Conceptions during or after the
Father's Duty in SEA
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Adverse Rate (n)	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=492)	Low	94	170.2(16)	1.00(0.82,1.22)	0.983
	Medium	242	165.3(40)		
	High	156	160.3(25)		
b) D>5 ppt (n=662)	Low	141	191.5(27)	0.96(0.83,1.11)	0.592
	Medium	292	174.7(51)		
	High	229	157.2(36)		

Ranch Hands - Log_2(Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=459)	****	****	M-AGE* DIOXIN(p=0.004)
d) D>5 ppt (n=607)	****	****	OCC*DIOXIN (p=0.002) C-TIME*DIOXIN (p=0.038) M-AGE*DIOXIN (p=0.009)

Total Adverse Outcome (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-31 [a]), there is significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.024). This significance is due to a reversal in risk with time since duty in SEA. The risk among conceptions of Ranch Hands with late tours is greater than 1.0 (OR=1.25, 95% CI 0.97-1.70, p=0.166) and among conceptions of Ranch Hands with early tours it is less than 1.0 (0.77, 95% CI 0.58-1.02, p=0.067).

Without adjustment for covariates (Table 3-31 [b]), there is no significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA among full siblings fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.572). Furthermore, there is no significant association between total adverse outcome and current dioxin among full siblings of fathers with late (p=0.865) or early tours (p=0.308).

After adjustment for covariates (Table 3-31 [c]), there is significant variation in the association between total adverse outcome and current dioxin with time since duty in SEA among full siblings fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.001). This significance is due to significantly increased risk among conceptions of fathers with late tours (OR=1.40, 95% CI 1.00-1.96, p=0.050) and significantly decreased risk among conceptions of fathers with early tours (OR=0.80, 95% CI 0.70-0.92, p=0.001).

After adjustment for covariates (Table 3-31 [d]), there is significant variation in the association between total adverse outcome and current dioxin level with time since duty in SEA and the father's military occupation in SEA (p=0.017) among full siblings fathered by Ranch Hands having more than 5 ppt current dioxin. The basis for this variation in risk is displayed in Appendix Table A-1. These stratified analyses found a significant reversal in risk with time since duty in SEA among conceptions of enlisted flyers (p=0.006). There is a borderline significantly increased risk among conceptions of enlisted flyers who had early (OR=3.58, 95% CI 1.15-11.1, p=0.025) tours and a non-significant decreased risk in conceptions of fathers with late tours (OR=0.32, 95% CI 0.07-1.55, p=0.157). If this interaction is ignored, there is no significant change in the association between total adverse outcome and current dioxin with time since duty in SEA (p=0.444). Furthermore, there is no significant association between total adverse outcome and current dioxin among conceptions of fathers with late (p=0.863) or early (p=0.390) tours.

Table 3-31

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands
Conceptions during or after the
Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Adverse Rate (No./n) Current Dioxin Low	Medium	High	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=493)						0.024
	≤18.6	113.2 (6/53)	143.9 (19/132)	150.7 (11/73)	1.25(0.91,1.70)	0.166
	>18.6	317.1 (13/41)	200.0 (22/110)	119.0 (10/84)	0.77(0.58,1.02)	0.067
b) D>5 ppt (n=546)						0.572
	≤18.6	213.3 (16/75)	134.1 (22/164)	165.2 (19/115)	0.98(0.79,1.22)	0.865
	>18.6	131.1 (8/61)	229.6 (31/135)	160.7 (18/112)	0.90(0.74,1.1)	0.308

Ranch Hands - Log_2(Current), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=460)			0.001	OCC(p=0.087)
	≤18.6	1.40(1.00,1.96)	0.050	
	>18.6	0.80(0.70,0.92)	0.001	
d) D>5 ppt (n=607)			0.444***	OCC*TIME* DIOXIN(p=0.017)
	≤18.6	1.02(0.80,1.31)***	0.863***	
	>18.6	0.90(0.72,1.14)***	0.390***	

Total Adverse Outcome (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-32 [a]), there is no significant overall association between total adverse outcome and categorized current dioxin among full siblings (p=0.434). Additionally, there is no significant difference between the total adverse outcome rate among conceptions fathered by Ranch Hands in the High current dioxin category and the rate among conceptions fathered by Comparisons in the Background category (p=0.795). Corresponding contrasts of conceptions of Ranch Hands in the Low (p=0.228) and Unknown (p=0.385) categories with conceptions of Comparisons in the Background category are not significant.

After adjustment for covariates (Table 3-32 [b]), there is significant variation in the association between total adverse outcome and categorized current dioxin with the mother's age at the time of the conception (p=0.039). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found a borderline significant increased rate among conceptions fathered by Ranch Hands in the Unknown category relative to the rate among conceptions fathered by Comparisons in the Background category with the mother being less than or equal to 27 years old at the time of the conception (OR=1.61 95% CI 0.93-2.81, p=0.089).

When this interaction is ignored (Table 3-32 [b]), there is no significant overall association between total adverse outcome and categorized current dioxin (p=0.369). Furthermore, there is no significant difference between the total adverse outcome rate in conceptions fathered by Ranch Hands in the High (p=0.870), Low (p=0.103) or Unknown (p=0.979) categories and the rate in conceptions fathered by Comparisons in the Background category.

Table 3-32

Post-SEA Counts and Rates of Total Adverse Outcome

Variable: Total Adverse Outcome
Restrictions: Full Siblings of Ranch Hands and Comparisons
Conceptions during or after the
Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Adverse Rate (n)	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	946	170.2(161)	All Exp Categ		0.434
Unknown	264	193.2(51)	Unk vs Bkgd	0.86(0.60,1.22)	0.385
Low	166	132.5(22)	Low vs Bkgd	1.34(0.83,2.17)	0.228
High	227	163.0(37)	High vs Bkgd	1.05(0.71,1.56)	0.795
Total	1603				

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	833	All Exp Categ		0.369***	SMOKE(p=0.004)
Unknown	232	Unk vs Bkgd	1.01(0.68,1.50)***	0.979***	OCC(p=0.050)
Low	155	Low vs Bkgd	0.65(0.39,1.09)***	0.103***	M-AGE*DIOXIN
High	211	High vs Bkgd	1.04(0.68,1.58)***	0.870***	(p=0.039)
Total	1431				

Total Conceptions (All Conceptions)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-33 [a]), there is no significant association between total conceptions and initial dioxin among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.796).

Without adjustment for covariates (Table 3-33 [b]), there is no significant association between total conceptions and initial dioxin among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.256).

After adjustment for covariates (Table 3-33 [c] and [d]), there is no significant association between total conceptions and initial dioxin among conceptions fathered by Ranch Hands with more than 10 ppt current dioxin (p=0.614) or more than 5 ppt current dioxin (p=0.447).

Table 3-33

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands Conceptions during or after the Father's Duty in SEA
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Mean	Coefficient (Std. error)	p-Value
a) D>10 ppt (n=274) (R^2=0.002)	Low	56	2.43	1.000(3.854)	0.796
	Medium	139	2.23		
	High	79	2.42		
b) D>5 ppt (n=388) (R^2=0.009)	Low	94	2.12	4.395(3.859)	0.256
	Medium	177	2.21		
	High	117	2.39		

Ranch Hands - Log_2(Initial Dioxin) - Adjusted

Exposure Restriction	Coefficient (Std. error)	p-Value	Covariate Remarks
c) D>10 ppt (n=240) (R^2=0.406)	-1.622(3.212)	0.614	OCC(p=0.094) SMOKE(p=0.090) RACE(p=0.102) DRINK(p=0.003) F-AGE(p=0.002) C-TIME(p=0.001)
d) D>5 ppt (n=338) (R^2=0.383)	-2.281(2.995)	0.447	RACE(p=0.049) DRINK(p=0.023) SMOKE(p=0.006) F-AGE(p=0.001) C-TIME(p=0.001)

Total Conceptions (All Conceptions)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-34 [a]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.209). Furthermore, there is no significant association between total conceptions and current dioxin among conceptions fathered by Ranch Hands with late (p=0.151) or early (p=0.800) tours.

Without adjustment for covariates (Table 3-34 [b]). there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.388). However, total conceptions increases borderline significantly with current dioxin (coefficient=5.261, std error=3.112) among conceptions fathered by Ranch Hands with late tours (p=0.092). Total conceptions do not change significantly with current dioxin among conceptions fathered by Ranch Hands with early tours (p=0.576).

After adjustment for covariates (Table 3-34 [c]), there is significant variation in the association between total conceptions and current dioxin with time since duty in SEA among conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.050). However, there is no significant association between total conceptions and current dioxin among conceptions fathered by Ranch Hands who had late (p=0.137) or early (p=0.222) tours.

After adjustment for covariates (Table 3-34 [d]), there is no significant variation in the association between total adverse outcome and current dioxin level with time since duty in SEA among conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.210). Furthermore, there is no significant association between total conceptions and current dioxin among conceptions fathered by Ranch Hands who had late (p=0.670) or early (p=0.320) tours.

Table 3-34

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands Conceptions during or after the Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Mean Conceptions (n) Current Dioxin Low	Medium	High	Coefficient (Std. error)	p-Value
a) D>10 ppt (n=275) (R^2=0.008)						0.209
	≤18.6	2.24 (34)	2.30 (70)	2.47 (36)	4.497(3.113)	0.151
	>18.6	2.36 (25)	2.28 (64)	2.33 (46)	-0.653(2.568)	0.800
b) D>5 ppt (n=388) (R^2=0.009)						0.388
	≤18.6	2.11 (56)	2.18 (97)	2.57 (53)	5.261(3.112)	0.092
	>18.6	2.03 (38)	2.20 (83)	2.39 (61)	1.415(2.525)	0.576

Table 3-34 (Continued)

Ranch Hands - Log_2(Current), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Coefficient (Std. error)	p-Value	Covariate Remarks
c) D>10 ppt (n=241) (R^2=0.420)			0.050	RACE(p=0.058) F-AGE(p=0.004)
	≤18.6	7.446(4.976)	0.137	DRINK(p=0.004) C-TIME(p=0.001)
	>18.6	-5.841(4.751)	0.222	OCC(p=0.087) SMOKE(p=0.087)
d) D>5 ppt (n=338) (R^2=0.386)			0.210	RACE(p=0.043) F-AGE(p=0.002)
	≤18.6	1.966(4.603)	0.670	DRINK(p=0.024) SMOKE(p=0.006)
	>18.6	-4.294(4.304)	0.320	C-TIME(p=0.001)

Total Conceptions (All Conceptions)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-35 [a]), there is a significant overall association between total conceptions and categorized current dioxin (p=0.022). The average number of conceptions fathered by Ranch Hands in the High category is significantly greater than that fathered by Comparisons in the Background category (p=0.014). There is no significant difference between the mean number of conceptions fathered by Ranch Hands in the Low (p=0.996) and Unknown (p=0.155) categories with the mean number fathered by Comparisons in the Background category.

After adjustment for covariates (Table 3-35 [b]), there is no significant overall association between total conceptions and categorized current dioxin (p=0.575). There is no significant difference between the mean number of conceptions fathered by Ranch Hands in the High (p=0.900), Low (p=0.400) and Unknown (p=0.209) categories and the mean number fathered by Comparisons in the Background category.

Table 3-35

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: All Conceptions of Ranch Hands and Comparisons Conceptions during or after the Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Mean Conceptions	Category Contrast	Difference of Rank Means (95% C.I.)	p-Value
Background	570	2.17	All Exp Categ		0.022
Unknown	178	2.06	Unk vs Bkgd	-31.89(-76.26,12.48)	0.155
Low	98	2.16	Low vs Bkgd	-0.14(-56.65,56.37)	0.996
High	114	2.47	High vs Bkgd	66.13(13.11,119.15)	0.014
Total	960				

b) Adjusted

Exposure Category	n	Category Contrast	Diff. of Adj. Rank Means (95% C.I.)	p-Value	Covariate Remarks
Background	476	All Exp Categ		0.575	F-AGE(p=0.002)
Unknown	152	Unk vs Bkgd	-17.68(-45.07,9.72)	0.209	C-TIME(p=0.001)
Low	88	Low vs Bkgd	-13.13(-43.50,17.20)	0.400	SMOKE(p=0.023)
High	97	High vs Bkgd	1.97(-27.69,31.63)	0.900	
Total	813				

Total Conceptions (Full Siblings)

Model 1: Conceptions of Ranch Hands - Log_2(Initial Dioxin)

Without adjustment for covariates (Table 3-36 [a] and [b]), there is no significant association between total conceptions and initial dioxin among full siblings fathered by Ranch Hands having more than 10 ppt (p=0.391) current dioxin, while there is a borderline significant positive association between total conceptions and initial dioxin among full siblings fathered by Ranch Hands having more than 5 ppt (p=0.103).

After adjustment for covariates (Table 3-36 [c] and [d]), there is no significant association between total conceptions and initial dioxin among full siblings fathered by Ranch Hands having more than 10 ppt (p=0.452) or more than 5 ppt (p=0.898) current dioxin.

Table 3-36

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands
Conceptions during or after the Father's Duty in SEA
Model 1: Log_2(Initial Dioxin)

Ranch Hands - Log_2(Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Mean	Coefficient (Std. error)	p-Value
a) D>10 ppt (n=227) (R^2=0.003)	Low	43	2.28	2.967(3.454)	0.391
	Medium	116	2.12		
	High	68	2.34		
b) D>5 ppt (n=320 (R^2=0.008)	Low	75	1.99	5.648(3.454)	0.103
	Medium	144	2.08		
	High	101	2.31		

Ranch Hands - Log_2(Initial Dioxin) - Adjusted

Exposure Restriction	Coefficient (Std error)	p-Value	Covariate Remarks
c) D>10 ppt (n=207) (R^2=0.393)	-2.041(2.710)	0.452	DRINK(p=0.018) SMOKE(p=0.019) F-AGE(p=0.063) C-TIME(p=0.001)
d) D>5 ppt (n=289) (R^2=0.384)	-0.345(2.704)	0.898	DRINK(p=0.016) SMOKE(p=0.001) F-AGE(p=0.022) C-TIME(p=0.001)

Total Conceptions (Full Siblings)

Model 2: Conceptions of Ranch Hands - Log_2(Current Dioxin) and Time

Without adjustment for covariates (Table 3-37 [a]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among full sibling conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.395). Furthermore, there is no significant association between total conceptions and current dioxin among conceptions fathered by Ranch Hands with late (p=0.138) or early (p=0.675) tours.

Without adjustment for covariates (Table 3-37 [b]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among full sibling conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.589). However, total conceptions increases borderline significantly with current dioxin (coefficient= 4.750, std error=2.772) among conceptions fathered by Ranch Hands with late tours (p=0.088). Total conceptions do not change significantly with current dioxin among conception fathered by Ranch Hands with early tours (p=0.267).

After adjustment for covariates (Table 3-37 [c]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among full sibling conceptions fathered by Ranch Hands having more than 10 ppt current dioxin (p=0.142). Furthermore, there is no significant association between total conceptions and current dioxin among conception fathered by Ranch Hands who had late (p=0.141) or early tours (p=0.535).

After adjustment for covariates (Table 3-37 [d]), there is no significant variation in the association between total conceptions and current dioxin with time since duty in SEA among full sibling conceptions fathered by Ranch Hands having more than 5 ppt current dioxin (p=0.179). Furthermore, there is no significant association between total conceptions and current dioxin among conceptions of Ranch Hands who had late (p=0.286) or early (p=0.610) tours.

Table 3-37

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands
Conceptions during or after the
Father's Duty in SEA
Model 2: Log_2(Current Dioxin), Time

Ranch Hands - Log_2(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Mean Conceptions (n) Current Dioxin Low	Medium	High	Coefficient (Std. error)	p-Value
a) D>10 ppt (n=228)						0.395
(R^2=0.01)	≤18.6	2.07 (27)	2.27 (59)	2.34 (32)	4.199(2.811)	0.138
	>18.6	2.21 (19)	2.11 (53)	2.24 (38)	0.957(2.279)	0.675
b) D>5 ppt (n=320)						0.589
(R^2=0.02)	≤18.6	2.02 (40)	2.07 (81)	2.51 (47)	4.750(2.772)	0.088
	>18.6	1.88 (34)	2.01 (68)	2.28 (50)	2.499(2.244)	0.267

Ranch Hands - Log_2(Current), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Coefficient (Std. error)	p-Value	Covariate Remarks
c) D>10 ppt (n=208)			0.142	DRINK(p=0.017) C-TIME(p=0.001)
(R^2=0.408)	≤18.6	5.632(3.798)	0.141	SMOKE(p=0.017)
	>18.6	-2.422(3.890)	0.535	
d) D>5 ppt (n=289)			0.179	DRINK(p=0.015) SMOKE(p=0.001)
(R^2=0.392)	≤18.6	4.502(4.206)	0.286	F-AGE(p=0.066) C-TIME(p=0.001)
	>18.6	-1.950(3.817)	0.610	

Total Conceptions (Full Siblings)

Model 3: Conceptions of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 3-38 [a]), there is a significant overall association between total conceptions and categorized current dioxin among full siblings (p=0.019). The average number of conceptions fathered by Ranch Hands in the High category is significantly greater than that fathered by Comparisons in the Background category (p=0.014). There is no significant difference between the mean number of conceptions fathered by Ranch Hands in the Low (p=0.829) and Unknown (p=0.155) categories with the mean number fathered by Comparisons in the Background category.

After adjustment for covariates (Table 3-38 [b]), there is significant variation in the association between total conceptions and categorized current dioxin with the mother's smoking (p=0.036). The basis for this variation is displayed in Appendix Table A-1. These stratified analyses found a significant association between total conceptions and categorized current dioxin if the mother smoked during pregnancy (p=0.035). The total conceptions among the mothers who smoked during pregnancy in the Low and Unknown categories are significantly and borderline significantly higher than that in the Background category (p=0.012 and p=0.071, respectively). None of the remaining four contrasts show an association between total conceptions and categorized current dioxin.

When the interaction with the mother's smoking is ignored, there is no significant overall association between total conceptions and categorized current dioxin among full siblings (p=0.478). The average number of conceptions fathered by Ranch Hands in the High (p=0.396), Low (p=0.591) and Unknown (p=0.230) categories are not significantly different from the average number fathered by Comparisons in the Background category.

Table 3-38

Post-SEA Total Conceptions

Variable: Total Conceptions
Restrictions: Full Siblings of Ranch Hands and Comparisons
Conceptions during or after the
Father's Duty in SEA
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Mean Conceptions	Category Contrast	Difference of Rank Means (95% C.I.)	p-Value
Background	475	2.07	All Exp Categ		0.019
Unknown	145	1.92	Unk vs Bkgd	-29.36(-69.87,10.80)	0.155
Low	82	2.05	Low vs Bkgd	5.39(-45.68,56.45)	0.829
High	97	2.39	High vs Bkgd	60.31(12.73,107.9)	0.014
Total	799				

b) Adjusted

Exposure Category	n	Category Contrast	Difference of Adj. Rank Means (95% C.I.)	p-value	Covariate Remarks
Background	407	All Exp Categ		0.478***	SMOKE*DIOXIN
Unknown	127	Unk vs Bkgd	-15.67(-41.19,9.85)***	0.230***	(p=0.036)
Low	75	Low vs Bkgd	-7.80(-36.16,20.55)***	0.591***	SMOKE(p=0.001)
High	87	High vs Bkgd	11.89(-15.37,39.14)***	0.396***	DRINK(p=0.048)
					C-TIME
Total	696				(p=0.001)

3.4 Conclusion

These analyses addressed the statistical significance of associations between dioxin and miscarriage, total adverse outcome and total conceptions. Total adverse outcome was defined as miscarriage, tubal pregnancy, other non-induced abortive pregnancies, or stillbirth. Both pre-post SEA and post-SEA analyses were carried out using Models 1, 2 and 3.

Throughout this section, nonsignificant results are indicated by NS, borderline significant results are indicated by NS* and the presence of interactions with the p-value greater than or equal to 0.01 and less than 0.05 are indicated with a preceding double asterisk (**). Four asterisks (****) represent the presence of an interaction between a covariate and dioxin with a p-value less than 0.01. The p-value is replace by a double hyphen (--) when the analysis was not carried out due to sparse data.

As displayed in Table 3-2, of 2951 pre-SEA pregnancies of Ranch Hands and Comparisons satisfying the Model 3 assumptions, 2499 (84.7%) resulted in live births, 395 (13.4%) resulted in miscarriage and 57 (1.9%) resulted in induced abortion, tubal pregnancy, other abortive pregnancy or stillbirth. The corresponding percentages among post-SEA conceptions were similar. These analyses were limited by the data to miscarriage, total adverse outcome, and total conceptions.

The pre-post SEA analyses of miscarriage, total adverse outcome and total conceptions are summarized in Table 3-39.

Table 3-39

P-Value Summary of Pre-Post SEA Analyses of Miscarriage, and Total Adverse Outcome and Total Conceptions

a) Model 1 - Log_2(Initial Dioxin)

Outcome	Sibship	D>10 ppt	D>5 ppt
Miscarriage	All conceptions	NS	NS
	Full siblings	NS	NS
Total Adverse Outcome	All conceptions	NS	NS
	Full siblings	NS	NS
Total Conceptions	All conceptions	NS	NS
	Full siblings	0.026	0.033

Table 3-39 (Continued)

b) Model 2 - Log_2(Current Dioxin) and Time Since Duty in SEA

Outcome	Sibship	D>10 ppt	D>5 ppt
Miscarriage	All conceptions	0.014	0.024
	Full siblings	NS*	NS*
Total Adverse Outcome	All conceptions	0.025	0.045
	Full siblings	NS*	NS*
Total Conceptions	All conceptions	NS	NS*
	Full siblings	0.048	0.025

c) Model 3 - Categorized Current Dioxin

Outcome	Sibship	All	Contrasts with Background: Unknown	Low	High
Miscarriage	All conceptions	NS	NS	NS	NS
	Full siblings	NS	NS	NS	NS
Total Adverse Outcome	All conceptions	NS	NS	NS	NS
	Full siblings	NS	NS	NS	NS
Total Conceptions	All conceptions	NS	NS	NS	0.026
	Full siblings	NS	NS	NS	0.036

A pre-post SEA Model 3 analysis without restriction to full sibling conceptions found a significant association between categorized dioxin and total conceptions, caused by increased number of post-SEA conceptions fathered by Ranch Hands in the High category (mean=2.47) relative to the number of conceptions fathered by Comparisons in the Background category (mean=2.17). Significant associations in Model 1 analyses in full sibling conceptions are caused by increasing mean numbers of post-SEA conceptions with dioxin. Significant associations in Model 2 analyses between dioxin and total conceptions among full sibling conceptions were caused by the number of post-SEA conceptions fathered by Ranch Hands having late tours increasing with dioxin, opposite to the corresponding decreasing pre-SEA trends. These findings do not support and sometimes contradict the hypothesis that high levels of dioxin

kill the developing embryo. Thus, these data do not support the theory that fertility is reduced at high levels of paternal dioxin. The "expected dose-response pattern" therefore is the linear one in which anomaly rates are highest at the highest levels of dioxin.

Table 3-4 shows that the pre-post SEA Model 2 miscarriage findings are caused by increasing miscarriage rates in conceptions fathered by Ranch Hands with late tours, opposite to the corresponding decreasing pre-SEA trends. These patterns are without credible interpretation and are inconsistent with the negative results based on Models 1 and 3. They therefore appear unrelated to dioxin.

Significant findings in pre-post SEA analyses of total adverse outcome were produced by increasing trends in post-SEA conceptions fathered by Ranch Hands with early tours and decreasing trends in conceptions of Ranch Hands with late tours (Table 3-10), opposite to corresponding pre-SEA trends. Like those of miscarriage, these findings are without credible interpretation, are inconsistent with the negative results of Models 1 and 3 and therefore appear unrelated to dioxin.

Analyses of post-SEA miscarriage, total adverse outcome and total conceptions, as summarized in Tables 3-40 through 3-42 were predominantly negative.

Table 3-40

P-Value Summary of Initial Dioxin (Model 1) Analyses of Post-SEA Miscarriage, Total Adverse Outcome and Total Conceptions

Outcome	Sibship	Unadjusted D>10 ppt	Unadjusted D>5 ppt	Adjusted D>10 ppt	Adjusted D>5 ppt
Miscarriage	All conceptions	NS	NS	****	NS
	Full siblings	NS	NS	****	NS
Total Adverse Outcome	All conceptions	NS	NS	****	****
	Full siblings	NS	NS	****	****
Total Conceptions	All conceptions	NS	NS	NS	NS
	Full siblings	NS	NS*	NS	NS

Table 3-41

P-Value Summary of Current Dioxin and Time (Model 2) Analyses of Post-SEA Miscarriage, Total Adverse Outcome and Total Conceptions

a) Unadjusted

Outcome	Sibship	D>10 ppt C by Time	D>10 ppt Time Since SEA (years) ≤18.6	D>10 ppt Time Since SEA (years) >18.6	D>5 ppt C by Time	D>5 ppt Time Since SEA (years) ≤18.6	D>5 ppt Time Since SEA (years) >18.6
Miscarriage	All conceptions	0.022	NS*	NS	NS	NS	NS
	Full siblings	NS*	NS	NS	NS	NS	NS
Total Adverse Outcome	All conceptions	0.012	NS	0.032	NS	NS	NS
	Full siblings	0.024	NS	NS*	NS	NS	NS
Total Conceptions	All conceptions	NS	NS	NS	NS	NS*	NS
	Full siblings	NS	NS	NS	NS	NS*	NS

b) Adjusted

Outcome	Sibship	D>10 ppt C by Time	D>10 ppt Time Since SEA (years) ≤18.6	D>10 ppt Time Since SEA (years) >18.6	D>5 ppt C by Time	D>5 ppt Time Since SEA (years) ≤18.6	D>5 ppt Time Since SEA (years) >18.6
Miscarriage	All conceptions	****	****	****	**NS	**NS	**NS
	Full siblings	**NS*	**0.009	**NS	**NS	**NS	**NS
Total Adverse Outcome	All conceptions	**0.009	**0.011	**NS	****	****	****
	Full siblings	0.001	0.050	0.001	**NS	**NS	**NS
Total Conceptions	All conceptions	0.050	NS	NS	NS	NS	NS
	Full siblings	NS	NS	NS	NS	NS	NS

Table 3-42

P-Value Summary of Categorized Current Dioxin (Model 3) Analyses of Post-SEA Miscarriage, Total Adverse Outcome and Total Conceptions

a) Unadjusted

Outcome	Sibship	Contrasts with Background All	Unknown	Low	High
Miscarriage	All conceptions	NS	NS	NS	NS
	Full siblings	NS	NS	NS	NS
Total Adverse Outcome	All conceptions	NS	NS	NS	NS
	Full siblings	NS	NS	NS	NS
Total Conceptions	All conceptions	0.022	NS	NS	0.014
	Full siblings	0.019	NS	NS	0.014

b) Adjusted

Outcome	Sibship	Contrasts with Background All	Unknown	Low	High
Miscarriage	All conceptions	**NS	**NS	**NS	**NS
	Full siblings	NS	NS	NS	NS
Total Adverse Outcome	All conceptions	****	****	****	****
	Full siblings	**NS	**NS	**NS*	**NS
Total Conceptions	All conceptions	NS	NS	NS	NS
	Full siblings	**NS	**NS	**NS	**NS

With regard to post-SEA miscarriages, an unadjusted Model 2 analysis found significant variation in the association between dioxin and miscarriage with time since tour in conceptions fathered by Ranch Hands with more than 10 ppt current dioxin. Table 3-22 shows that this finding was caused by increasing miscarriage rates in conceptions of Ranch Hands with late tours and decreasing rates in conceptions of Ranch Hands with early tours. That dioxin should act adversely in one stratum of Ranch Hands and beneficially in another is difficult to conceptualize and, therefore, this finding appears unrelated to dioxin.

Adjusted analyses of post-SEA miscarriage were either negative or were complicated by significant changes in effect with covariates. There is no pattern common to the 16 interactions and most were not consistent with the expected dose-response. For example, an adjusted Model 2 analysis (Table 3-22) found a significant interaction with the father's military occupation in SEA. Among officers, miscarriages decrease with dioxin and among enlisted personnel there were no consistent patterns. In some enlisted strata the highest miscarriage rate occurs in conceptions of fathers having intermediate dioxin levels and in one stratum, the highest rate occurs in conceptions of fathers with the lowest dioxin level. An adjusted Model 3 analysis (Table 3-23) found significant interaction with the mother's age. In mothers aged 27 or younger, Ranch Hands in the High category had a higher miscarriage rate (175.4 per 1000) than Comparisons in the Background category (126.0 per 1000), but among mothers older than 27 the rate in the High category (126.6 per 1000) was less than the rate in the Background category (147.1 per 1000). An adjusted Model 1 analysis restricted to full sibling conceptions also found a significant interaction with the mother's age. Miscarriages decreased with dioxin in conceptions of mothers aged 27 or less and increased with dioxin in conceptions of mothers older than 27. In summary, the post-SEA miscarriage findings were either nonsignificant or, if significant, were inconsistent with the expected dose-response or were complicated by covariate interactions that upon examination revealed no patterns suggestive of a dioxin effect. These findings are therefore most likely not related to dioxin.

Post-SEA analyses of total adverse outcome were either negative, found significant associations caused by inconsistent trends without credible explanation or were complicated by interactions with covariates. For example adjusted Model 1 analyses (Table 3-27) found a significant interaction with the mother's age in conceptions fathered by Ranch Hands with more than 10 ppt and with the father's race and military occupation in conceptions fathered by Ranch Hands with more than 5 ppt dioxin. The interaction with the mother's age was caused by a positive association with in dioxin in mothers aged 27 or younger and essentially no association in mothers older than 27. The interactions with race and military occupation were caused by a negative association in nonblack enlisted ground personnel, a positive association in Black enlisted ground personnel and a positive association in nonblack officers. Analyses based on Models 2 and 3 also found changes in association with the father's military occupation and the mother's smoking (Tables 3-28 and 3-29) but examination of these interactions revealed no meaningful or consistent patterns. These results were generally weak, inconsistent and were sometimes contradictory or opposite to the expected dose response. They are therefore most likely not related to dioxin.

Post-SEA analyses of total conceptions were either negative, inconsistent, or found positive associations between total conceptions and dioxin. For example, an adjusted Model 2 analysis (Table 3-34) found a significant interaction with time since tour, caused by an increasing number of conceptions fathered by Ranch Hands with late tours and a decreasing number fathered by Ranch Hands with early tours, but neither of these were significant. Two unadjusted Model 3 analyses (Tables 3-35 and 3-38) found significant associations caused Ranch Hands in the High dioxin category having more conceptions

than Comparisons in the Background category. These findings contradict the theory that high levels of dioxin kill the embryo and are not indicative of an adverse effect of dioxin on total conceptions.

In summary, we find no evidence that dioxin is adversely associated with miscarriage, total adverse outcome or total conceptions. The observed increases in total conceptions with dioxin contradicts the theory that dioxin at high levels kills the embryo. Therefore, the "expected dose-response" has been reduced to a single hypothesis: increasing anomalies with increasing paternal dioxin.